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DEPARTMENT OF THE ARMY
U.S. ARMY CORPS OF ENGINEERS

CEGS-15970 (05/99)

Superseding
CEGS-15970 (Omaha)

GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION TABLE OF CONTENTS

DIVISION 15 - MECHANICAL

SECTION 15970

PUMP CONTROL AND ANNUNCIATION SYSTEM

05/99

PART 1 GENERAL

1.1 REFERENCES
1.2 GENERAL REQUIREMENTS
1.3 SUBMITTALS
1.3.1 GENERAL
1.3.2 Submittals
1.4 SYSTEM OVERVIEW
1.4.1 General
1.5 EXPERIENCE AND QUALIFICATIONS
1.6 WARRANTY

PART 2 PRODUCTS

2.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS
2.1.1 Enclosure
2.1.2 Ventilation System
2.1.3 Ground Bar
2.1.4 Standard Indicator Lights
2.1.5 Selector Switches
2.1.6 Pushbuttons
2.1.7 Relays
2.1.8 Nameplates
2.1.9 Transient Voltage Surge Suppression Devices
2.1.10 Terminal Blocks
2.1.11 Power Conditioners (Constant Voltage Transformer Type)
2.1.12 Miscellaneous Power Supplies
2.1.13 Alarm Annunciator
2.1.14 Alarm Horns
2.1.15 2 Pen Recorder
2.1.16 Operator Interface Panel
2.1.17 Laptop Computer
2.1.17.1 Hardware
2.1.17.2 Software
2.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE
2.2.1 General
2.2.2 Central Processing Unit Module

2.2.3 Power Supply Module
2.2.4 Program Storage/Memory Requirements
2.2.5 Input/Output (I/O) Modules
2.2.6 Interfacing
2.2.7 Program Requirements
2.2.8 Diagnostics
2.3 GRAPHICS DISPLAY PANEL
2.3.1 Enclosure
2.3.2 Display Presentation
2.3.3 Digital Net Flow and Level Indicators

PART 3 EXECUTION

3.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS
3.1.1 General
3.1.2 Shop Tests
3.1.3 Ventilation System
3.1.4 Grounding
3.1.5 Indicator Lights, Switches, and Pushbuttons
3.1.6 Transient Voltage Surge Suppression Devices
3.1.7 Terminal Blocks
3.1.8 Power Conditioners
3.1.9 Power Supplies
3.1.10 Alarm Annunciator and Horns
3.1.10.1 Non-critical Alarms
3.1.10.2 Critical Alarms
3.1.10.3 Alarm Sequence
3.1.11 2 Pen Recorder
3.1.12 Operator Interface Panel
3.1.12.1 Screen Number 1
3.1.12.2 Screen Number 2
3.1.12.3 Screen Number 3
3.1.12.4 Screen Number 4
3.1.12.5 Screen Number 5
3.1.13 Laptop Computer
3.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE
3.2.1 General
3.2.2 Programs
3.3 GRAPHICS DISPLAY PANEL
3.3.1 General
3.3.2 Display Presentation
3.3.3 Process Schematic
3.3.4 Digital Net Flow and Level Indicators
3.4 INSTALLATION
3.4.1 Shop Drawing
3.4.2 System Start-Up and Testing
3.4.3 Training Plan for Instructing Personnel
3.5 TOOLS AND SPARE PARTS*\
3.6 PLC CONTROL SYSTEM SEQUENCE OF OPERATION
3.6.1 General
3.6.1.1 Abbreviations
3.6.2 Operating Tanks
3.6.2.1 Level Control
3.6.2.2 Outlet Valve
3.6.3 Product Recovery Tank
3.6.3.1 Fuel Transfer Pump (FTP)
3.6.3.2 Overfill Valve (OV)
3.6.3.3 High Level Alarm
3.6.3.4 Leak Detection

3.6.4 Fueling Pumps (FP)
3.6.5 Flow Switch, Fueling Pump
3.6.6 Transmitters
3.6.6.1 Pressure Indicating Transmitter (PIT)
3.6.6.2 Differential Pressure Transmitter (DPT)
3.6.7 Control Valves
3.6.7.1 Defuel/Flush Valve (D/FV)
3.6.7.2 Pressure Control Valve (PCV)
3.6.7.3 Backpressure Control Valve (BPCV)
3.6.8 Safety Circuit
3.6.8.1 Emergency Stop Status
3.6.8.2 Emergency Shutoff Valves (ESO) Status
3.6.8.3 Circuit Power Status
3.6.9 Pump Control Panel
3.6.9.1 CPU Faults
3.6.9.2 Input Select Switch
3.6.9.3 Mode Select Switch
3.6.9.4 Lead Pump Selector Switch
3.6.9.5 PCP Temperature Alarm
3.7 OPERATING PROGRAM REQUIREMENTS
3.8 AUTOMATIC MODE - IDLE CONDITION
3.9 AUTOMATIC MODE - REFUELING CONDITION
3.10 AUTOMATIC MODE - DEFUELING CONDITION
3.11 FLUSH MODE
3.12 OFF MODE
3.13 MANUAL OPERATION OF FUELING PUMPS

-- End of Section Table of Contents --

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GUIDE SPECIFICATION FOR CONSTRUCTION

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SECTION 15970

PUMP CONTROL AND ANNUNCIATION SYSTEM
05/99

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NOTE: This guide specification covers the requirements for the Pump Control and Annunciation System for aircraft refueling systems as part of the Air Force Type III Standard (78-24-28-88). This guide specification is to be used in the preparation of project specifications in accordance with ER 1110-345-700 for military construction and in accordance with ER 1110-2-1201 for Civil Works construction.

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PART 1 GENERAL

1.1 REFERENCES

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NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest change (Notice) to this guide specification. During the reference reconciliation process, SPECSINTACT will automatically remove references from this paragraph that have been removed from the text.

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The publications listed below form a part of this specification to the extent referenced. The publications are referred to in the text by basic designation only.

AMERICAN NATIONAL STANDARDS INSTITUTE (ANSI)

ANSI C37.90	(1989; R 1994) Relays and Relay Systems Associated with Electric Power Apparatus

INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE)

IEEE C62.41	(1991) Surge Voltages in Low Voltage AC Power Circuits

NATIONAL ELECTRICAL MANUFACTURERS ASSOCIATION (NEMA)

NEMA 250	(1991) Enclosures for Electrical Equipment (1000 Volts Maximum)
NEMA IA 2	(1994) Programmable Controllers
NEMA ICS 1	(1993) Industrial Control and Systems
NEMA ICS 2	(1993) Industrial Control Devices, Controllers and Assemblies
NEMA ICS 3	(1993) Industrial Systems
NEMA ICS 4	(1993) Industrial Control and Systems Terminal Blocks
NEMA ICS 6	(1993) Enclosures for Industrial Control and Systems
NEMA LS 1	(1992) Low Voltage Surge Protective Devices

NATIONAL FIRE PROTECTION ASSOCIATION (NFPA) PUBLICATION

NFPA 70	(1999) National Electrical Code

INSTRUMENT SOCIETY OF AMERICA (ISA)

ISA S18.1	(1979; R 1992) Annunciator Sequences and Specifications

UNDERWRITERS' LABORATORY INC. (UL) PUBLICATION

UL 508	(1993) Industrial Control Equipment
UL 1012	(1994) Power Units Other than Class 2
UL 1449	(1985) Transient Voltage Surge Suppressors

1.2 GENERAL REQUIREMENTS

Section [16050 BASIC ELECTRICAL MATERIALS AND METHODS] [16415 ELECTRICAL WORK, INTERIOR] applies to this section, with the additions and modifications specified herein. The control system shall be furnished by a single supplier. See specification 15050 for other required components of the control system. The control system supplier shall be responsible for providing a fully functional control system, in accordance with the drawings and specifications, including the field devices. Installation shall be in accordance with NFPA 70.

1.3 SUBMITTALS

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NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

Indicate submittal classification in the blank space using "GA" when the submittal requires Government approval or "FIO" when the submittal is for information only.

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1.3.1 GENERAL

Data shall be submitted in accordance with the overall requirements detailed in Section [16050 BASIC ELECTRICAL MATERIALS AND METHODS] [01330 SUBMITTAL PROCEDURES] and the specific requirements of this section. Documents shall consist of a complete list of equipment and materials, manufacturer's descriptive and technical literature, brochures, catalog cuts, performance specifications, diagrams, and other material as stated in subsequent subparagraphs. The Contractor shall submit additional material if the listed items are not adequate to identify intent or conformance to technical requirements. Any delays associated with resubmittals of incomplete or ambiguous initial submittals will be the Contractor's responsibility.

1.3.2 Submittals

Government approval is required for submittals with a "GA" designation; submittals having an "FIO" designation are for information only. The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES. As a minimum the following must be submitted in accordance with the specific subparagraphs noted:

SD-01 Data

Pump Control Panel (PCP) and Components; GA.

Programmable Logical Controller (PLC) Hardware and Software; GA.

Graphics Display Panel; GA.

Documents demonstrating the accuracy and completeness of the list of material and components, that items proposed comply fully with contract requirements, and are otherwise suitable for the application indicated. Documents shall consist of all data or drawings published by the manufacturer of individual items listed including manufacturer's descriptive and technical literature, performance data, catalog cuts, and installation instructions.

Tools and Spare Parts; FIO.

SD-04 Drawings

Shop Drawing; GA.

SD-08 Statements

Experience and Qualifications; GA.

Plan for Instructing Personnel; GA.

Testing Plan; GA.

SD-09 Reports

Certified Pump Control Panel (PCP) Shop Test Report; FIO.

Record of Test; FIO.

SD-19 Operation and Maintenance Manuals

Operation and Maintenance Manuals; GA.

Six copies of Operational and Maintenance manuals, within 7 calendar days following the completion of factory tests.

Operational and Maintenance manuals shall be furnished following the completion of shop tests and shall include:

a. Pump Control Panel and Graphics Display Panel assembly including interior and exterior equipment layout.

b. All documents previously submitted and approved with all comments and field changes annotated.

c. Complete description of the sequence of operation including that described in Paragraphs 3.6 through 3.13 of this specification and any subsystems not controlled by the PLC (e.g. annunciator panel, EPDS, etc.)

d. Complete listing of all programming of the PLC and Graphical Interface.

e. Complete relay ladder logic diagrams, PLC input/output diagrams and control power distribution diagrams for the complete control system.

f. Complete guide outlining step-by-step procedures for system startup and operation.

g. Complete troubleshooting guide, which lists possible operational problems and corrective action to be taken.

h. Complete maintenance and installation manual for all equipment supplied.

i. Spare parts data, which provides supplier name, current cost, catalog order number, and a recommended list of spare parts to be stocked.

j. The above shall incorporate all as-built conditions.

Documents shall be bound in a suitable binder adequately marked or identified on the spine and front cover. A table of contents page shall be included and marked with pertinent contract information and contents of the manual. Tabs shall be provided to separate different types of documents, such as catalog ordering information, drawings, instructions, and spare parts data. Index sheets shall be provided for each section of the manual when warranted by the quantity of documents included under separate tabs or dividers.

1.4 SYSTEM OVERVIEW

1.4.1 General

The Hydrant Fueling System consists of fueling pumps that pump fuel to a [Hydrant Hose Truck Check-out Pad,] [Pantograph Flushing Connection,] Truck Fill Stands, and fuel pits located on the airfield apron. Automatic pump starts and stops are based on system pressure and flow. Programmable Logic Controllers (PLCs) receive information from pressure transmitters and other devices to control the pumps and control valves. There are two PLCs that are connected in a redundant configuration if one fails. The Hydrant Fueling System also includes above ground fuel storage tanks and product recovery tanks. The pump control panel and annunciator are located in the Control Room of the Pumphouse.

1.5 EXPERIENCE AND QUALIFICATIONS

Submit the following data for approval:

a. Certification stating that the manufacturer has manufactured and installed at least three PLC-based systems for automatic cycling of pumps based upon varying dispensing demands ranging from 0 to 2400 gallons per minute utilizing multiple pumps. At least one of the three PLC-based systems shall be for dispensing jet fuel into aircraft fuel tanks.

b. Certification that the control systems have successfully operated over the last 2 years and are currently in service.

c. Project names, locations, and system description of these installations. Include user point-of-contact and current telephone numbers.

1.6 WARRANTY

The Pump Control and Annunciation System including devices, hardware and software shall be warranted for a period of 1 year from the date of acceptance of the system by the Government. This warranty service shall include parts and labor service for equipment supplied under this specification. Upon notification by the Government of system or component failure, the Contractor shall respond at the site with necessary parts within 48 HOURS of notification.

PART 2 PRODUCTS

2.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS

2.1.1 Enclosure

NEMA ICS 1, NEMA ICS 6, NEMA 250, and UL 508. The PCP enclosure shall be a freestanding NEMA Type 12, smooth, gasketed enclosure constructed of 12 gauge steel. All seams shall be continuously welded and there shall be no drilled holes or knockout prior to delivery to the job site. The pump control panel dimensions shall be a maximum of 90 inches high, maximum 72 inches wide, and a maximum of 24 inches deep and shall have removable lifting eyes. The interior surfaces of the panel shall be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces shall have standard factory finish. Access for the PCP shall be front only and shall consist of hinged doors having 3-point latching mechanisms. The doors shall open approximately 120

degrees. Rack mounting angles, swing-out panels and other component mounting hardware shall be installed such that servicing of one component shall not require removal or disconnection of other components. No clearance shall be required between the back of the panel and the room walls. Terminal facilities shall be arranged for entrance of external conductors from the top or bottom of the enclosure. The Graphic Display Panel may be fed from the side of the PCP enclosure.

2.1.2 Ventilation System

Two supply fans, single phase, 115 volt, shall be provided. Each fan shall supply a minimum of 100 CFM. The supply and exhaust grill shall contain a filter that is easily removed from the exterior of the enclosure. Three thermostats with an adjustable set point range of 70EF to 140EF shall also be provided. The thermostats shall be located near the top in the interior of the PCP.

2.1.3 Ground Bar

The control panel shall have a tin plated copper equipment ground bar. The bar shall have a minimum of twenty grounding screws.

2.1.4 Standard Indicator Lights

NEMA ICS 1, NEMA ICS 2, and UL 508. Lights shall be heavy duty, NEMA 13, 22.5 mm mounting hole, round indicating lights operating at 120 volts ac/dc or 24 volts ac/dc. Long life bulbs shall be used. Indicator lights shall have a legend plate with words as shown on drawings. Lens color as indicated on the drawings. Lights shall be "push to test (lamp)" type.

2.1.5 Selector Switches

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated lever operated selector switches shall be heavy duty, NEMA 13, round, and utilize a 22.5mm mounting hole. They shall have the number of positions as indicated on the drawings. Switches shall be rated 600 volt, 10 amperes continuous. Legend plates shall be provided with each switch with words as indicated on the drawings.

2.1.6 Pushbuttons

NEMA ICS 1, NEMA ICS 2, and UL 508. Non-illuminated pushbuttons shall be heavy duty, NEMA 13, round, utilize a 22.5mm mounting hole, and have the number and type of contacts as indicated on the drawings or elsewhere in the specifications. The emergency stop switch shall be a red mushroom head, 1.5 inch diameter, momentary contact type. Pushbuttons shall be rated 600 volt, 10 amperes continuous. Legend plates shall be provided with each switch with words as indicated on the drawings.

2.1.7 Relays

ANSI C37.90, NEMA ICS 2, UL 508.

2.1.8 Nameplates

Nameplates shall be made of laminated plastic with black outer layers and a white core. Edges shall be chamfered. Nameplates shall be

fastened with black-finished round-head drive screws or approved nonadhesive metal fasteners.

2.1.9 Transient Voltage Surge Suppression Devices

IEEE C62.41 for Category "B" transients, NEMA LS 1, UL 1449.

2.1.10 Terminal Blocks

NEMA ICS 4. Terminal blocks for conductors exiting the PCP shall be two-way type with double terminals, one for internal wiring connections and the other for external wiring connections. Terminal blocks shall be made of bakelite or other suitable insulating material with full deep barriers between each pair of terminals. A terminal identification strip shall form part of the terminal block and each terminal shall be identified by a number in accordance with the numbering scheme on the approved wiring diagrams.

2.1.11 Power Conditioners (Constant Voltage Transformer Type)

UL 1012. Input voltage shall be 120 volts (nominal), 1 phase, 60 Hertz.

Output voltage regulation shall be +/-5.0% for the following conditions:

a. 20% to 100% load on output.
b. Input voltage variation of -15% to +10%.
c. Constant load power factor between 80% and 100%.

Response time shall be 1.5 cycles or less.

2.1.12 Miscellaneous Power Supplies

UL 1012. Certain field devices may require power other than 120VAC (i.e. 24VDC). The power supplies shall be convection cooled, have fully isolated independent outputs, have constant voltage, have short circuit and overvoltage protection, and have automatic current limiting.

2.1.13 Alarm Annunciator

UL 508 and ISA S18.1. The Alarm Annunciator shall provide visual annunciation, local and remote monitoring, constant or flashing visual and audible alarm as specified herein. The annunciator shall be completely solid state with no moving parts. The annunciator shall be furnished with cabinet and hardware appropriate for flush mounting on the control panel. A power supply either integral or separately mounted shall operate on 120 volts, 60 Hertz. The annunciator shall have windows arranged in a matrix configuration (rows and columns). Each window shall be at least 15/16 inch high by 1-5/8 inches wide and shall have rear illuminated translucent engraved nameplate. Lettering shall be at least 5/32 inches high. System lamp voltage shall be 24 to 28 volts dc.

2.1.14 Alarm Horns

UL 508. The alarm horns shall consist of 2-vibrating horns and 1-resonating horn. One vibrating horn is to be mounted in the PCP, and one vibrating and one resonating horn shall be mounted outside of the control room as shown on the drawings. The exterior horns shall each

produce 100db at 10 feet and shall be provided in a weather proof housing. The PCP horn shall produce 70db at 10 feet.

2.1.15 2 Pen Recorder

UL 508. The recorder shall be totally enclosed in a case suitable for flush or semiflush mounting and have:

a. Two channels for continuous analog recording of input data
b. Digital printer for periodic printout of chart speed, date, time, channel tags, scale, engineering units, etc.
c. 5 x 7 dot matrix, 20 character (minimum digital display) for display of input values, engineering units, setup parameters, etc.
d. Function keys for setup and control
e. Power on/off switch.

The recorder shall meet or exceed the following:

a. Input Signal	4-20mA
b. Accuracy	0.5% of calibrated span
c. Repeatability	0.25% of calibrated span
d. Input/Pen Motion	linear/continuous
e. Speed of Response	less than 2 seconds for full scale travel
f. Pen Drive	Servo motor with overrange protection
g. Pens	long lasting disposable marker in highly visible contrasting colors
h. Chart Speed	Variable with 1 inch/hour to 8 inches/hour minimum
i. Plotting Chart	Removable chart cassette with 4" nominal width Z-fold strip chart, minimum 50 feet long

2.1.16 Operator Interface Panel

UL 508. The operator interface panel shall be a NEMA 4/12, 14" color VGA CRT with sealed membrane keypads for data entry. It shall include a Pentium CPU operating at a minimum of 133MHz. It shall be mounted through the PCP door as shown on the drawings. The operator interface shall communicate with the PLCs to display system status and change system set points. The operator interface shall have run-time graphical software to display the graphical screens that were downloaded from the Laptop computer and change set points.

2.1.17 Laptop Computer

2.1.17.1 Hardware

The following are the minimum hardware requirements for the laptop computer:

a. Latest Pentium CPU or compatible
b. 32-48K Meg RAM
c. 1 - 2 G hard drive
d. 3 1/2" floppy drive
e. Color VGA LCD screen 12.1"
f. Keyboard
g. Pointing device (e.g. mouse, track ball)
h. Parallel communication port

i. Serial communication port compatible with PLC (e.g. RS-232-C, RS-485)
j. 120VAC and Battery power supply
k. All cables and connectors for interfacing with PLC and operator interface panel
l. Modem compatible for remote troubleshooting of the system

2.1.17.2 Software

The following is the minimum software to be loaded on the laptop. The software shall be the most current versions and compatible with each other to make a complete and usable system. All software shall be year 2000 compliant.

a. Operating system (e.g. MS-DOS, Windows, OS/2)
b. Software for programming the PLC
c. Software for programming the operator interface panel

2.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

2.2.1 General

a. NEMA IA 2. Each PLC shall be able to receive discrete and analog inputs and through its programming it shall control discrete and analog output functions, perform data handling operations and communicate with external devices and remote I/O racks. The PLCs shall be a modular, field expandable design allowing the system to be tailored to the process control application. The capability shall exist to allow for expansion to the system by the addition of hardware and/or user software. At a minimum the PLCs shall include mounting backplanes, power supply modules, CPU module, communication modules, and I/O modules. The PLC software shall be year 2000 compliant.

b. Each PLC provided shall be designed and tested for use in the high electrical noise environment of an industrial plant. The PLC modules shall comply with the Federal Communication Commission's Standard 15J Part A for radio noise emissions. The programmable controller processor shall be able to withstand conducted susceptibility tests as outlined in NEMA ICS 2, NEMA ICS 3, ANSI C37.90.

c. The PLCs shall function properly at temperatures between 32 and 122 degrees F, at 5 to 95 percent relative humidity non-condensing and have storage temperatures between -40 and +140 degrees F at 5 to 95 percent relative humidity non-condensing.

d. The PLCs shall have manufacturer's standard system status indicators (e.g. power supply status, system fault, run mode status, back-up battery status).

2.2.2 Central Processing Unit Module

The CPU shall be a modular self-contained unit that will provide time of day, scanning, application (ladder rung logic) program execution, storage of the application program, storage of numerical values related to the application process and logic, I/O bus traffic control, peripheral and external device communications and self-diagnostics.

2.2.3 Power Supply Module

a. The power supply module shall be plugged into the backplane not separately mounted. The power supply shall be wired to utilize 120 VAC, 60 Hz power, the system shall function properly within the range of -10% to +15% of nominal voltage. The power supply shall provide an output to the backplane at a wattage and voltage necessary to support the attached modules. A single main power supply module shall have the capability of supplying power to the CPU module and local communication and I/O modules. Auxiliary power supplies shall provide power to remote racks.

b. Each power supply shall have an integral on/off disconnect switch to the module. If the manufacturers standard power supply does not have an on/off disconnect switch a miniature toggle type switch shall be installed near the PLC and clearly labeled as to its function.

c. The power supply shall monitor the incoming AC line voltage for proper levels and have provisions for both over current and over voltage protection. If the voltage level is detected as being out of range the system shall have adequate time to complete a safe and orderly shutdown.

2.2.4 Program Storage/Memory Requirements

a. The PLC shall have the manufacturers standard nonvolatile executive memory for the operating system. The PLC shall also have EEPROM (Electrically Erasable Programmable Read Only Memory) for storage of the user program and battery backup RAM for application memory. The EEPROM shall be loaded by use of the laptop computer.

b. The contractor shall submit a calculation of the required amount of EEPROM and RAM (random access memory) needed for this application plus an extra 50 percent.

c. The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory capacity to store these instructions.

2.2.5 Input/Output (I/O) Modules

a. The Contractor shall provide all required I/O modules (analog input, analog output, discrete input, discrete output, and isolated discrete output) to manipulate the types of inputs and outputs as shown on the drawings and to comply with the sequence of operations. The Contractor shall also provide a minimum of 20% (round up for calculation) spare input and output points of each type provided, but not less than 2 of each type.

b. I/O modules shall be a self-contained unit housed within an enclosure to facilitate easy replacement. All user wiring to I/O modules shall be through a heavy-duty terminal strip. Pressure-type screw terminals shall be used to provide fast, secure wire connections. The terminal block shall be removable so it is possible to replace any input or output module without disturbing field wiring.

c. During normal operation, a malfunction in any remote input/output channel shall affect the operation of only that channel and not the operation of the CPU or any other channel.

d. Isolation shall be used between all internal logic and external power circuits. This isolation shall meet the minimum specification of 1500 VRMS. Provide optically isolated I/O components which are

compatible with field devices.

e. Each I/O module shall contain visual indicators to display ON/OFF status of individual input or output points.

f. Discrete output modules shall be provided with self-contained fuses for overload and short circuit protection of the module.

g. All input/output modules shall be color coded and titled with a distinctive label.

2.2.6 Interfacing

The PLC shall have communication ports and communication modules using the manufacturers standard communication architecture for connections of the Operator Interface Panel, Laptop Computer, remote I/O racks and interconnections between SYS 1 PLC and SYS 2 PLC for the redundant backup system of the PLCs.

2.2.7 Program Requirements

a. The programming format shall be ladder diagram type as defined by NEMA IA 2.

b. There shall be a means to indicate contact or output status of the contact or output on the CRT (of the operator interface panel) or LCD screen (of the laptop computer). Each element's status shall be shown independently, regardless of circuit configuration.

c. The program shall be full featured in its editing capabilities (e.g. change a contact from normally open to normally closed, add instructions, change addresses, etc.).

2.2.8 Diagnostics

The CPU shall continuously perform self-diagnostic routines that will provide information on the configuration and status of the CPU, memory, communications and I/O. The diagnostic routines shall be regularly performed during normal system operation. A portion of the scan time of the controller should be dedicated to perform these housekeeping functions. In addition, a more extensive diagnostic routine should be performed at power up and during normal system shutdown. The CPU shall log I/O and system faults in fault tables, which shall be accessible for display. When a fault shuts down a CPU, a sequence shall be initiated that will automatically switch over to the other CPU. When a fault affects I/O or communication modules the CPU shall shut down only the hardware affected and continue operation by utilizing healthy system components. All faults shall be annunciated on the alarm annunciator.

2.3 GRAPHICS DISPLAY PANEL

2.3.1 Enclosure

The Graphics Display Panel (GDP) enclosure shall be a wall mount, NEMA Type 12, smooth enclosure constructed of 12 gauge steel. Panel dimensions shall be 36+4 inches high, 48+4 inches wide, and a maximum of 6 inches deep. The interior surfaces of the panel shall be properly cleaned, primed, and spray painted with white high-gloss enamel. Exterior surfaces shall have standard factory finish.

2.3.2 Display Presentation

The process schematic graphic representation shall be adhered to a permanent aluminum substrate. Red, green, and amber LEDS or miniature raised lens indicator lights shall be integrated with the process schematic to provide current equipment status graphically. The lights shall be a minimum of 1/2" (12 millimeters) in diameter. A lamp test push button shall also be incorporated into the panel.

2.3.3 Digital Net Flow and Level Indicators

Digital indicators shall be provided to indicate the net flow in GPM of the system and the level in the product recovery tank. The digital indicators shall display the indicated number of digits as shown on the drawings. Each digit shall be a 7-segment red LED approximately 0.6-inches high. The indicators shall be powered by 120 VAC or 24 VDC and shall receive a 4-20mA data signal.

PART 3 EXECUTION

3.1 PUMP CONTROL PANEL (PCP) AND COMPONENTS

3.1.1 General

a. Wiring methods and practices shall be in accordance with NEMA ICS 1,2,3,4, and 6 recommendations as applicable. Where two or more pieces of equipment performing the same function are required, they shall be exact duplicates produced by the same manufacturer. All display instruments of each type shall represent the same outward appearance, having the same physical size and shape, and the same size and style of numbers, characters, pointers, and lamp lenses.

b. The PCP shall include all required resident software programs and hardware to provide the specified sequence of operation. All software floppy disks including programming manuals shall be turned over to the Government at the completion of start-up so modification can be done in the field with no outside assistance.

c. It is intended that process controlling devices except field devices, and motor controllers be attached to or mounted within the PCP enclosure and all interconnecting wiring installed prior to shipment to the job site. This is to allow shop testing of the system and to decrease field labor requirements.

d. The PCP shall be shipped fully assembled in one piece after the completion of the shop tests and all defects corrected.

3.1.2 Shop Tests

Certified Pump Control Panel (PCP) Shop Test Report

The manufacturer shall shop test the PCP and GDP. The procedure shall include simulation of field components and shall provide for fully testing the pump control and annunciator system as a unit before delivery to the project site. The test shall, reveal system defects, including, but not limited to, functional deficiencies, operating program deficiencies, algorithm errors, timing problems, wiring errors, loose connections, short circuits, failed components and misapplication

of components. The test shall be performed prior to shipment to the site and problems detected shall be corrected. The final testing and correction sequence shall be repeated until no problems are revealed and then two additional successful tests shall be performed. Submit certified test report within 15 days after completion of the test. The report shall include a statement that the Pump Control Panel performs as specified. The Contractor shall notify the Government 30 days prior to the final shop testing date. The Contracting Officer may require a Government witness at the final test before the PCP is shipped to the site.

3.1.3 Ventilation System

Thermostat T-1, shall control fan F-1 and thermostat T-2 shall control fan F-2. T-1 and T-2 shall be set at 80EF to maintain interior air temperature to 20EF above ambient. Thermostat T-3, set at 100EF, shall provide a non-critical PCP HIGH TEMPERATURE alarm to the alarm annunciator.

3.1.4 Grounding

The PCP ground bar shall be connected to the building counterpoise via a #10 AWG conductor. Within the enclosure all I/O racks, processor racks, and power supplies, etc. shall be grounded to meet the manufacturer's specifications.

3.1.5 Indicator Lights, Switches, and Pushbuttons

Indicator lights, switches, and pushbuttons shall be mounted through the PCP enclosure and shall be arranged to allow easy vision and operation of each device. Each device shall have a nameplate and/or legend plate as indicated on the drawings. Nameplate wordings shall be as indicated on the drawings.

3.1.6 Transient Voltage Surge Suppression Devices

Transient voltage surge suppression (TVSS) devices shall be installed in the PCP to minimize effects of nearby lightning strikes, switching on and off motors and other inductive loads. TVSS shall be provided for each control circuit ladder. Each ladder may contain any combination of the following devices: PLCs, power supplies (e.g., 24 volt), fans, relays, lights, switches etc. TVSS shall also be provided for PLC I/O originating outside of the building.

3.1.7 Terminal Blocks

As a minimum, any PCP device that connects to a field device (devices not located in the PCP) shall be connected to a terminal block. A connection diagram similar to the drawings shall be provided to the field contractor for field connections to the PCP.

3.1.8 Power Conditioners

The Pump Control Panel (PCP) shall contain three power conditioners each connected to a dedicated circuit. As shown on the drawings one power conditioner shall supply PLC System 1, one power conditioner shall supply PLC System 2, and the third power conditioner shall supply the miscellaneous device power. The power conditioners output capacity shall be sufficient to drive all the equipment connected plus 25%.

3.1.9 Power Supplies

The Contractor shall provide and install all 120VAC and 24VDC power supplies as required. The power supplies shall be sized for the load plus 25%. All field devices, which require power and are controlled or monitored from the PCP, shall be supplied from power supplies in the pump control panel. A 120V receptacle shall be provided in the PCP for use by the Laptop computer. Interconnecting wiring between power conditioners and PLC power supplies shall be completely installed prior to shipment to the job site.

3.1.10 Alarm Annunciator and Horns

Signals shall be initiated by hardwired field contacts or by PCP outputs as required. The annunciator shall energize alarm horns, both an integral panel mounted vibrating horn and remote horns, and flash the appropriate annunciator lamp. The minimum number of windows shall correspond to the number of alarm points, plus 15 percent spare. The drawings indicate panel layout and the alarms to be annunciated.

3.1.10.1 Non-critical Alarms

Non-critical alarm windows shall be white with black lettering and shall sound the PCP mounted vibrating horn and the exterior mounted vibrating horn.

3.1.10.2 Critical Alarms

Critical alarm windows shall be red with white lettering and shall sound the PCP mounted vibrating horn and the exterior mounted resonating horn. Critical alarms shall also cancel all automatic pump starts in the PLC.

3.1.10.3 Alarm Sequence

Alarm sequence for each alarm shall be as follows (ISA S18.1 sequence 'A').

a. For a normal condition, visual indicator and horns will be off.
b. For an alarm condition, visual indicator will flash and horns will sound (this condition will be locked in).
c. Upon acknowledgment of the alarm condition, visual indicator will be steady on and the horns will be off.
d. If, after acknowledgment of an alarm condition, another alarm condition is established, the new alarm will cause the appropriate window to flash and the horn to sound.
e. When condition returns to normal after acknowledgment, the visual indicator and the horn will be off.

3.1.11 2 Pen Recorder

Channel one shall record net flow (0 to 2400 GPM). Flow is measured using the Differential Pressure Transmitters (DPT) located at the issue and return venturi and net flow is the difference between the issue and return. Channel two shall record main pipeline pressure (0 to 300 psi).

Pressure is measured using the Pressure Indicating Transmitters (PIT). Zero for each scale shall appear at the bottom or left side of the scale segment. Multipliers applied to these scales shall be 1 or a power of 10.

3.1.12 Operator Interface Panel

The operator interface panel shall be mounted through the front panel of the PCP. Conductor routing shall allow the door to swing to the fully open position. The operator interface panel shall download system parameters from the PLC for display. The operator interface shall also upload new set point values that the operator has changed using the operator interface key pad, after a password has been entered.

3.1.12.1 Screen Number 1

This shall be a general opening screen. As a minimum it shall display the name and location of the installation (e.g. Travis Air Force Base, California), name of the project (e.g., Hydrant Fueling System 'Pumphouse Baker') and screen navigation information.

3.1.12.2 Screen Number 2

At a minimum the following items shall be displayed. The values shall be continuously updated, a 2 second delay maximum between updates will be acceptable.

a. System Issue Rate	xxxx GPM	
b. System Return Rate	xxxx GPM	
c. System Net Flow	xxxx GPM	
d. System Pressure	xxxx PSI	
e. System Operation Mode	Auto/Off/Flush	
f. Active System	Sys-1/Sys-2	
g. Lead Pump	1/2/3/4/5	
h. Fuel Pump #1	On/Off	xxxxx.x HOURS
i. Fuel Pump #2	On/Off	xxxxx.x HOURS
j. Fuel Pump #3	On/Off	xxxxx.x HOURS
k. Fuel Pump #4	On/Off	xxxxx.x HOURS
l. Fuel Pump #5	On/Off	xxxxx.x HOURS
m. Backpressure Control Valve	Closed/Enabled	
n. Pressure Control Valve	Closed/Enabled	
o. Defuel/Flush Valve	Closed/Defuel	
p. Tank #1 Outlet Valve	Open/Closed	
q. Tank #2 Outlet Valve	Open/Closed	
r. Receipt Bypass Valve	Open/Closed	

Only one of the words separated by a slash (/) shall be displayed. The xxxxx.x HOURS is the fuel pumps elapsed run time and the value shall not be lost when the lead PLC is switched. The pump and valve status words shall be color coded to match the colors used on the GDP.

3.1.12.3 Screen Number 3

The following table shall be displayed. The table lists the set points that can be adjusted using the operator interface. A password shall be entered before the "current value" can be adjusted. The value entered can only be a number within the "set point range". The "default value" is the value held in the program that is loaded into EEPROM memory (This screen may require more than one display screen.).

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE	CURRENT VALUE
Lead pump starting pressure	30 to 150 psi	60 psi	xxx psi
Issue flow to start second pump in the sequence	450 to 650 gpm	560 gpm	xxx gpm
Issue flow to start third pump in the sequence	1000 to 1300 gpm	1160 gpm	xxxx gpm
Issue flow to start fourth pump in the sequence	1600 to 1900 gpm	1760 gpm	xxxx gpm
Return flow to enable next pump in sequence to start	10 to 100 gpm	40 gpm	xxx gpm
Return flow to stop fourth third, and second pump in the sequence (lag pump)	500 to 800 gpm	700 gpm	xxx gpm
Return flow to initiate lead pump shutdown sequence	500 to 800 gpm	560 gpm	xxx gpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds	xx seconds
Timer to enable second, third and fourth pumps to start	0 to 120 seconds	10 seconds	xx seconds
Timer to stop fourth, third, and second pumps	0 to 120 seconds	15 seconds	xx seconds
Timer to stop first pump	0 to 60 seconds	2 seconds	xx seconds
Timer to disable Back Pressure Control Valve	0 to 360 seconds	60 seconds	xx seconds
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds	xx seconds
System pressure to stop lead pump	130 to 190 psig	140 psig	xxx psig

3.1.12.4 Screen Number 4

This screen shall be a duplicate of the Graphic Display Panel showing a schematic of the process flow.

3.1.12.5 Screen Number 5

This screen shall be a duplicate of the Alarm Annunciator and it shall be superimposed over the current active screen when an alarm is activated.

3.1.13 Laptop Computer

The Laptop computer shall be used to create, edit, and load the ladder logic program into the PLC and operator interface graphics control program into the operator interface panel. The Laptop shall also be used to monitor the PLC memory and ladder logic program. The computer shall be stored in a lockable cabinet located within the Pump Control Panel.

3.2 PROGRAMMABLE LOGICAL CONTROLLER (PLC) HARDWARE AND SOFTWARE

3.2.1 General

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NOTE: The pressure indicating transmitters and the differential pressure transmitters are the only devices that the PLC can monitor for a possible failure. A failure shall be defined by the transmitter going out of range on the low side (i.e. a signal less than 4mA).
****

The basic operation of the redundant PLC system is (Reference "Control System Block Diagram" on the drawings):

a. CPU-1 and it's associated I/O rack (I/O-1) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

b. CPU-2 and it's associated I/O rack (I/O-2) sends system outputs to appropriate devices and receive input signals from System-1 redundant field devices (PIT-1, DPT-1, DPT-3, flow switches, valve limit switches), System-2 redundant field devices (PIT-2, DPT-2, DPT-4, flow switches, valve limit switches), and all nonredundant field devices as listed on the drawings.

c. Within each rack (I/O-1 and I/O-2) System-1, System-2, and nonredundant inputs and outputs shall not be mixed on the same input/output module.

d. Under normal operation: The system input select switch is in the "SYS-1" position. CPU-1 is controlling the system using System-1 and nonredundant inputs from I/O-1 and any set point changes from the operator interface. CPU-2 is being updated by CPU-1 or concurrently monitoring System-1 inputs from I/O-2.

e. If under normal operation CPU-1 recognizes that a System-1 input has failed (see note below) it shall change over to the System-2 redundant input on I/O-1 and report the failure to the operator interface panel alarm screen.

f. During normal operation there are two ways for CPU-2 to take

control of the system: 1) CPU-1 identifies its own internal fault and hands over control to CPU-2. 2) CPU-2 identifies a fault in CPU-1 and takes control from CPU-1. When CPU-2 is in control of the system it shall annunciate the fault condition and shall be using any updated inputs from the operator interface and shall use System-1 inputs.

g. CPU-2 shall also report any of its internal faults to CPU-1 and CPU-1 shall report any faults it detects in CPU-2.

h. When the operators think the system is not working and the PLCs do not detect any faults the operator can move the system input select switch from the "SYS-1" position to the "SYS-2" position. With the switch in the "SYS-2" position the PLCs are using System-2 inputs.

3.2.2 Programs

a. The Contractor shall provide two copies of all working programs (i.e. PLC logic, operator interface) on 3-1/2 inch floppy disks as well as a printer program listing.

b. The Contractor (programmer) shall provide rung comments (documentation) in the ladder logic program. Each device, on the ladder, shall be identified as to the type of device, i.e. limit switch XX, flow indicator XX, motor starter XX, etc. Rung comments shall be provided for input and output rungs. The programmer shall also provide a comment describing the function of each rung or group of rungs that accomplish a specific function.

3.3 GRAPHICS DISPLAY PANEL

3.3.1 General

The graphic display panel shall be shipped fully assembled in one piece after it has been shop tested as an integral part of the pump control panel and all defects corrected.

3.3.2 Display Presentation

The Graphic Display shall depict the process fuel flow schematically as indicated on the drawings. Red, green, and amber LEDS or miniature raised lens indicator lights shall be integrated with the process schematic to provide current equipment status graphically. Lights shall be located immediately adjacent to related equipment symbol. The lamp test button shall test all the lamps simultaneously.

3.3.3 Process Schematic

The process schematic graphic representation shall utilize conventional symbols when possible. Symbols and flow lines shall be sized and spaced so as to provide a clear representation of the system process. All background colors, component colors, lettering and detail colors shall be laminate sealed with a clear epoxy coating which is chemical resistant yet provides the clarity of a polyester finish. Provide textured nonglare finish. The Graphic Display shall be suitable for supervised field modification when future items are added. The Graphic Display shall have a white background. Minor changes may be incorporated to allow proper line width and spacing. Component arrangement, piping routing, and location of valves shall match the flow diagram. The GDP layout shall be approved by the Government prior to the construction of

the GDP.

3.3.4 Digital Net Flow and Level Indicators

Digital indicators shall be panel mounted and indicate net flow in gpm and level in feet.

3.4 INSTALLATION

Installation shall conform to the manufacturer's drawings, written recommendations and directions.

3.4.1 Shop Drawing

The shop drawing shall be clear and readable and preferably drawn using a computer aided drafting package. At the conclusion of the project the diagram drawings shall be redrafted to include all as-built conditions. These updated drawings shall be included in the O&M Manuals and appropriate section of the drawings placed in a data pocket located in each of the enclosures. The shop drawing at a minimum shall show:

a. Overall dimensions, front, side and interior elevation views of the PCP showing size, location and labeling of each device.
b. Overall dimensions, front elevation of the GDP showing graphical layout and size, location and labeling of each device.
d. Power ladder diagram indicating power connections between TVSS, power conditioners, PLCs, power supplies and field and panel devices. Any terminal block connection numbers used shall be indicated.
e. Control ladder diagram indicating control connections between field and devices and PLC I/O modules. Terminal block connection numbers and PLC terminal numbers shall be indicated
f. Communication connections between PLCs and I/O racks. Communication channel numbers shall be indicated.
g. Bill of materials.
h. Written control sequence covering all inputs, outputs, and control scheme.

3.4.2 System Start-Up and Testing

a. At PCP start-up and testing the Contractor shall provide personnel, on site, to provide technical assistance, program fine tuning, and to start-up and test the system. Start-up and testing shall be coordinated with the overall fueling system start-up test specified in Section 15899, SYSTEM START-UP, FUELING. Prior to this test, all connections shall have been made between the PCP, the GDP, the motor control center, and all field devices. In addition, wiring shall have been checked for continuity and short circuits. The Contractor shall adjust set point values, timing values, and program logic as required to provide a functional hydrant fuel control system. Once the system has been fine tuned and passed the system test, the new system default values, shall be loaded into the PLC EEPROM and the operator interface screens adjusted to indicate the new values.

b. A step-by-step testing procedure of the PCP shall be submitted, Testing Plan. The test shall be designed to show that every device (lights, switches, operator interface display screens, alarms, etc.) on the PCP and GDP is in working order and that the PLC program controls the system per specifications. The test shall be performed in conjunction with Section 15899. The plan shall include a place for the contractor and government representative to initial each step of the plan after satisfactory completion and acceptance of each step. The complete initialed testing plan shall be certified by the contractor and then submitted, Record of Test.

3.4.3 Training Plan for Instructing Personnel

a. Upon completion of the system start-up a competent technician regularly employed by the PCP manufacturer shall hold a training class for the instruction of Government personnel in the operation and maintenance of the system. Provide both classroom type theory instruction and hands-on instruction using operating equipment provided. The period of instruction shall be a minimum of three 8-hour working days. The training shall be designed to accommodate 8 operators, 4 maintenance personnel, and 2 programmers. The Government shall receive written notice (via Contracting Officer) a minimum of 14 days prior to the date of the scheduled classes.

b. Furnish a written lesson plan and training schedule for Government approval at least 60 days prior to instructing operating, maintenance and programming personnel. Concurrently submit above to the MAJCOM for their input into the review process. Approval of lesson plan will be based on both Government and MAJCOM concurrence. This plan shall be tailored to suit the requirements of the Government. The training shall be divided into three separate classes. Each class shall be tailored to a specific group of personnel. The groups are: 1) Operators, those that will use the control system on a day to day basis; 2) Maintenance personnel, those that will perform routine and non-routine maintenance and trouble shooting of the control system; 3) Programmers, those that will make changes to and trouble shoot the PLC and operator interface programs. The training program shall provide:

(1) a detailed overview of the control system including the complete step-by-step procedures for start-up, operation and shut-down of the control system.
(2) a general overview of programmable logic controllers
(3) the maintenance of equipment installed
(4) the programming of the PLC and Operator Interface
(5) trouble shooting of the system

c. Complete approved Operation and Maintenance manuals for Specification 15970 PUMP CONTROL AND ANNUNCIATION SYSTEM and [16402 INTERIOR DISTRIBUTION SYSTEM] [16415 INTERIOR WIRING SYSTEMS] (specifically pertaining to the motor control center and its relay ladder diagrams) shall be used for instructing operating personnel. Training shall include both classroom and hands-on field instruction. The class shall be video taped in the VHS format.

d. The contractor shall also provide VHS formatted video taped training courses covering system overview, operation, maintenance, trouble shooting, and programming. These tapes shall be produced off-site by the contractor using the supplied Pump Control Panel as the teaching aid, or commercially produced tapes by the PLC manufacturer or

third party who specializes in training on PLC systems. Along with the tapes, provide workbooks, which follow along with the tapes.

3.5 TOOLS AND SPARE PARTS*\

The following shall be provided:

a. any special tools necessary for maintenance of the equipment
b. one spare set of fuses of each type and size
c. recommended manufacturer list of spare parts. Include part number, current unit price, and source of supply.
d. one spare power supply module
e. one spare I/O module (for discrete devices)
f. one spare I/O module (for analog devices)
g. 2 PLC RAM back-up batteries
h. 5 spare pens of each color for the chart recorder
i. 5 packages of chart paper for the chart recorder
j. minimum of 10 spare lamps for the Alarm Annunciator
k. minimum of 10 spare lamps of each type of non-LED lamps used on the Pump Control Panel and Graphic Display Panel

3.6 PLC CONTROL SYSTEM SEQUENCE OF OPERATION

3.6.1 General

The following describes general functions of the fueling system components.

3.6.1.1 Abbreviations

a. SYS-1: components of System #1 including power conditioner, power supplies, CPU-1, I/O-1, and system #1 input and outputs.
b. SYS-2: components of System #2 including power conditioner, power supplies, CPU-2, I/O-2, and system #2 input and outputs.
c. CPU-1: SYS-1 PLC CPU.
d. CPU-2: SYS-2 PLC CPU.
e. I/O-1: SYS-1 PLC input/output modules.
f. I/O-2: SYS-2 PLC input/output modules.
g. PCP: Pump Control Panel.
h. GDP: Graphical Display Panel.
i. OI: Operator Interface

3.6.2 Operating Tanks

3.6.2.1 Level Control

Each operating tank has three level float switches to measure low, high and high-high levels. The switches are DPDT for the redundancy and each pole shall be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing.

a. Low Level

When the low level float is activated the associated tank's GDP low level light shall light. If the outlet valve is not fully closed the alarm annunciator's critical alarm sequence activates, fueling pumps

running in automatic mode shall be disabled and no pump shall be allowed to start automatically. If all tanks are at low level, no fueling pumps shall start automatically.

b. High Level

When the high level float is activated the associated tank's GDP high level light shall light and the alarm annunciator's non-critical alarm sequence activates.

c. High-High Level

When the high-high level float is activated the associated tank's GDP high-high level light shall light, the alarm annunciator's critical alarm sequence activates, fueling pumps running in automatic mode shall be disabled and no pump shall be allowed to start automatically.

3.6.2.2 Outlet Valve

Each operating tank's outlet valve has a limit switch to indicate valve position. The switch is DPDT for redundancy and each pole shall be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The switch shall close when the valve is fully closed. When the limit switch is closed the associated tank's valve OI closed display and GDP closed light shall activate. When the limit switch is open, the associated tank's valve OI open display and GDP open light shall activate.

3.6.3 Product Recovery Tank

3.6.3.1 Fuel Transfer Pump (FTP)

The pump's motor controller has a status relay to indicate the on/off status of the pump. The status relay shall be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the pump's GDP off light shall light. When the status relay is closed the pump's GDP on light shall light. The status relay state shall also be used to start and stop the pumps elapsed run time timer.

3.6.3.2 Overfill Valve (OV)

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NOTE: The automatic starting and stopping of the fuel transfer pump is accomplished by the actuation of tank float switches connected to the control circuit in the motor control center. The PLC system does not control the starting and stopping.

****

The tank's overfill valve has a limit switch to indicate valve position. The switch is SPST and shall be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The switch shall close when the valve is fully closed. When the limit switch is closed the tank's GDP valve closed light shall light and the alarm annunciator's non-critical alarm sequence activates. When the limit switch is open the tank's GDP valve open light shall light.

3.6.3.3 High Level Alarm

The tank has a high level alarm float switch. The switch is SPST and shall be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the high level alarm float is activated the tank's GDP high level light shall light and the alarm annunciator's non-critical alarm sequence activates.

3.6.3.4 Leak Detection

The tank has a leak detection system. The leak detection systems alarm relay shall be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When the leak alarm is activated the alarm annunciator's non-critical alarm sequence activates.

3.6.4 Fueling Pumps (FP)

There are five fueling pumps with a maximum of four pumps running at one time. The lead pump selector switch shall select the pump starting sequence. Each pump's motor controller has a status relay to indicate the on/off status of the pump. The status relay shall be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. When status relay is open the associated pump's OI off display and GDP off light shall activate. When the status relay is closed the associated pump's OI on display and GDP on light shall activate. The status relay state shall also be used to start and stop the pumps elapsed run time timer and shall be displayed on the OI.

3.6.5 Flow Switch, Fueling Pump

On the discharge side of each pump is a flow switch to indicate positive flow (fail safe feature). The flow switch is DPDT for redundancy and each pole shall be connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. If the PLC has given a signal to start a pump and the flow switch has not closed before the set point timer expires or if the flow switch opens after the pump has been running then the pump shall be in a failure state and it shall be disabled (taken out of the starting sequence), the alarm annunciator's non-critical alarm sequence shall also be activated, and the next pump in the start sequence started. After the PLC has stopped all of the pumps, any failed pump shall be added back into the start sequence.

3.6.6 Transmitters

3.6.6.1 Pressure Indicating Transmitter (PIT)

The PIT's measure system pressure in psi. There are two PITs for redundancy. PIT-1 and PIT-2 are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The system pressure is sent to one channel of the 2-pin recorder and the OI display.

3.6.6.2 Differential Pressure Transmitter (DPT)

The DPT's measure flow in gpm. There are two issue DPTs (DPT-1 and DPT-2) and two return DPTs (DPT-3 and DPT-4) for redundancy. The DPTs are connected to both SYS-1 and SYS-2 as indicated on the Terminal Block Connection drawing. The net flow is sent to one channel of the 2-pin recorder and the digital indicator on the GDP. The issue rate, return rate and net flow shall be displayed on the OI.

3.6.7 Control Valves

3.6.7.1 Defuel/Flush Valve (D/FV)

The D/FV shall be connected to I/O-1, I/O-2 and power conditioner #3 as indicated on the Terminal Block Connection drawing. The GDP open and closed lights and OI display shall activate based on the PLC's output status for the valve. The valve status shall be based on the table listed below.

Defuel/Flush Valve Operation - Two Solenoids				
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid A	Solenoid B	Illuminated GDP Light
Flush Mode	Open	De-Energized	Energized	Open
Automatic Mode Pump(s) On	Closed	De-Energized	De-Energized	Closed
Automatic Mode Pumps Off	Enabled	Energized	De-Energized	Closed
Off Mode Pump(s) On	Closed	De-energized	De-Energized	Closed
Off Mode Pumps Off	Enabled	Energized	De-Energized	Closed

3.6.7.2 Pressure Control Valve (PCV)

The PCV shall be connected to I/O-1, I/O-2 and power conditioner #3 as indicated on the Terminal Block Connection drawing. The GDP enabled and closed lights and OI display shall activate based on the PLC's output status for the valve. The valve status shall be based on the table listed below.

Pressure Control Valve Operation - One Solenoid			
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid	Illuminated GDP Light
Automatic Mode Pumps Off	Enabled	De-Energized	Enabled
Automatic Mode Pump(s) On	Closed	Energized	Closed

Flush Mode Pumps On	Closed	Energized	Closed
Flush Mode Pumps Off	Enabled	De-Energized	Enabled
Off Mode Pump(s) On	Closed	Energized	Closed
Off Mode Pumps Off	Enabled	De-Energized	Enabled

3.6.7.3 Backpressure Control Valve (BPCV)

The BPCV shall be connected to I/O-1, I/O-2 and power conditioner #3 as indicated on the Terminal Block Connection drawing. The GDP enabled and closed lights and OI display shall activate based on the PLC's output status for the valve. The valve status shall be based on the table listed below.

Backpressure Control Valve Operation - One Solenoid			
Fueling Mode per PCP Selector Switch	Valve Action	Solenoid	Illuminated GDP Light
Automatic Mode Pump Start-up	Enabled	Energized	Enabled
Automatic Mode Prior to Lead Pump Shutoff	Closed	De-Energized	Closed
Flush Mode	Closed	De-Energized	Closed
Off Mode Pump(s) On	Enabled	Energized	Enabled
Off Mode Pumps Off	Closed	De-Energized	Closed

3.6.8 Safety Circuit

3.6.8.1 Emergency Stop Status

The emergency stop circuit status relay (ER1) N.O. contact shall be connected to I/O-1, I/O-2 and power conditioner #3 as indicated on the Terminal Block Connection drawing. When the circuit is activated the alarm annunciator's critical alarm sequence is activated and any calls to start fueling pumps shall be canceled and no additional pump start signals shall be sent until the circuit has been reset. The fueling pumps will actually be stopped by a emergency stop circuit status relay (ER2) N.O. contact in the fuel pump motor control circuit located in the motor control center.

3.6.8.2 Emergency Shutoff Valves (ESO) Status

The ESO status relay (ER2) N.O. contact shall be connected to I/O-1, I/O-2 and power conditioner #3 as indicated on the Terminal Block Connection drawing. When the relay is closed the GDP valve open lights shall light. When the relay is open the GDP valve closed lights shall light.

3.6.8.3 Circuit Power Status

The safety circuit power status relay (ER3) N.O. contact shall be connected to I/O-1, I/O-2 and power conditioner #3 as indicated on the Terminal Block Connection drawing. When the relay is closed the PCP emergency circuit power on light shall light.

3.6.9 Pump Control Panel

3.6.9.1 CPU Faults

The PCP mounted CPU-1 and CPU-2 on lights are connected to both SYS-1 and SYS-2. The associated CPU light shall light when no system faults are detected. When a fault is detected by the CPU or it's redundant CPU the faulted CPU's on light shall be turned off and the alarm annunciator's non-critical alarm sequence shall be activated.

3.6.9.2 Input Select Switch

The 2-position input select switch shall control which inputs (System-1 or System-2) are being used. Each switch position shall be connected to both SYS-1 and SYS-2. The OI display shall indicate the active system.

3.6.9.3 Mode Select Switch

The 3-position switch selects what mode of fueling is active: automatic, flush or off. Each switch position shall be connected to both SYS-1 and SYS-2. The OI display shall indicate the active mode.

3.6.9.4 Lead Pump Selector Switch

The 5-position switch selects which pump shall be the lead pump. The switch position shall fix the starting sequence for all pumps. The sequences shall be 1-2-3-4-5, 2-3-4-5-1, 3-4-5-1-2, 4-5-1-2-3, and 5-1-2-3-4. The off sequence shall be the reverse of the start sequence, therefore, first on will be last off. A maximum of four pumps will be allowed to run at one time. If a pump fails to start or fails during operation, that pump will be disabled and the next pump in the sequence started. The OI display shall indicate the lead pump.

3.6.9.5 PCP Temperature Alarm

The alarm thermostat when activated shall activate the alarm annunciator's non-critical alarm sequence.

3.7 OPERATING PROGRAM REQUIREMENTS

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NOTE: A number with < and > brackets around it in the following paragraphs indicates that the number may be changed by the operator via the operator interface with in the range listed above.

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The control system's logic program shall be stored on a EEPROM chip. Default values of operator adjustable parameters shall be permanently stored on the chip with the capability of resetting the values in RAM to the values with in the range specified below. The default values can be changed through the use of the Operator Interface Panel (after the

correct password has been entered). After loss of power and battery failure the adjustable settings shall revert back to the default values located on the chip. The default values shown here shall be reset to the values determined during the system start up and test.

SET POINT DESCRIPTION	SET POINT RANGE	DEFAULT VALUE
Lead pump starting pressure	30 to 150 psi	60 psi
Issue flow to start second pump in sequence	450 to 650 gpm	560 gpm
Issue flow to start third pump in sequence	1000 to 1300 gpm	1160 gpm
Issue flow to start fourth pump in sequence	1600 to 1900 gpm	1760 gpm
Return flow to enable next pump in sequence to start	10 to 100 gpm	40 gpm
Return flow to stop fourth, third, and second pump in sequence (lag pump)	500 to 800 gpm	700 gpm
Return flow to initiate lead pump shutdown sequence	500 to 800 gpm	560 gpm
Timer to enable start-up of lead pump	0 to 120 seconds	0 seconds
Timer to enable second, third, and fourth pumps to start	0 to 120 seconds	10 seconds
Timer to stop fourth, third, and second pumps	0 to 120 seconds	15 seconds
Timer to stop first pump	0 to 60 seconds	2 seconds
Timer to de-energize (close) Back Pressure Control Valve	0 to 360 seconds	60 seconds
Timer to establish fueling pump failure	5 to 30 seconds	15 seconds
System pressure to stop lead pump	130 to 190 psig	140 psig

Should the operator enter a value not within the range for that parameter, the Operator Interface Panel shall indicate "INVALID ENTRY" and revert back to the previous value.

3.8 AUTOMATIC MODE - IDLE CONDITION

The fueling system is intended to remain continuously pressurized while in the idle condition. This allows the system to respond immediately to aircraft refueling and defueling requirements. Periodically, in the

idle condition, the system will lose minimal pressure. When this occurs, the control system will automatically repressurize in the following sequence:

a. The lead pump will start when the system pressure is less than <60> psig continuously for <0> seconds. If the pressure then rises above <60> psig before the timer expires, the timer shall reset.

b. After the timer expires:

(1) The BPCV solenoid shall be energized to enable the valve to modulate the system pressure at it's set point.

(2) The PCV solenoid shall be energized to close the valve.

(3) The D/FV solenoid 'A' shall be de-energized so the valve is closed and solenoid 'B' shall be de-energized.

c. With the lead pump running, "600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 130 psig. At this pressure the BPCV will start to open and the valve will modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

d. With the lead pump running and no fueling demand the return venturi flow rate will equal the issue venturi flow rate. When the return venturi flow rate is greater than <560> gpm a <60> second timer shall start. If the flow rate drops below <560> before the timer expires, the timer shall reset, and no changes shall be made to the pump and valve status.

e. After the timer expires:

(1) The BPCV solenoid shall be de-energized to close the valve.

(2) The Defuel/Flush valve solenoid "A" shall be energized to bleed system pressure to 80 psig.

(3) The PCV solenoid shall be de-energized to bleed system pressure to 75 psig.

(4) When system pressure rises to 140 psig a <2> second timer shall start. After the timer has expired, the lead pump shall be stopped.

f. The system has now returned to a pressurized and idle condition.

g. When a fueling pump is called to start, a 15 second timer shall start. If the timer expires before the flow switch closes the pump shall be called off, the alarm annunciator's associated non-critical alarm sequence shall activate and the next pump in the sequence shall be called to start.

h. If a fueling pumps flow switch opens after the pump has successfully started the pump shall be called off, the alarm annunciator's associated non-critical alarm sequence shall activate and

the next pump in the sequence shall be called to start.

3.9 AUTOMATIC MODE - REFUELING CONDITION

To start an aircraft fueling operation, an operator connects fueling equipment such as a [hydrant hose truck][hydrant cart][pantograph] to an aircraft and to a hydrant control valve. When the operator opens the hydrant control valve by use of an [air][hydraulic] operated "Deadman", the following sequence occurs:

a. The lead pump will start when the PIT senses a pressure less than <60> psig continuously for <0> seconds. If the pressure then rises above <60> psig before the timer expires, the timer shall reset.

b. After the timer expires:

(1) The BPCV solenoid shall be energized to enable the valve to modulate the system pressure at it's set point.

(2) The PCV solenoid shall be energized to close the valve.

(3) The D/FV solenoid 'A' shall be de-energized so the valve is closed and solenoid 'B' shall be de-energized.

c. With the lead pump running, ±600 gpm will flow through the issue venturi. The system pressure upstream of the BPCV will increase to the BPCV set point of 130 psig. At this pressure the BPCV will start to open and the valve will modulate as required to pass sufficient flow through the return venturi to maintain pressure upstream of the valve.

d. With lead pump running and a issue venturi flow rate greater than <560> gpm and a return venturi flow rate greater than <40> gpm and less than <560> gpm the lead pump will continue to run and the BPCV will modulate to pass flow as necessary to maintain upstream system pressure.

e. With the lead pump running and a issue venturi flow rate greater than <560> gpm and a return venturi flow rate greater than <560> gpm a <60> second timer shall start. If issue venturi flow rate falls below <560> gpm or the return venturi flow rate falls below <560> before the timer expires, the timer shall reset, and no changes shall be made to the pump and valve status.

f. After the timer expires:

(1) The BPCV solenoid shall be de-energized to close the valve.

(2) The Defuel/Flush valve solenoid "A" shall be energized to bleed system pressure to 80 psig.

(3) The PCV solenoid shall be de-energized to bleed system pressure to 75 psig.

(4) When system pressure rises to 140 psig a <2> second timer shall start. After the timer has expired, the lead pump shall be stopped.

g. With the lead pump running and a issue venturi flow rate greater than <560> gpm and a return venturi flow rate less than <40> gpm a <10> second timer shall start. If the issue venturi flow rate falls below <560> gpm or the return venturi flow rate rises above <40> gpm before the timer expires, the timer shall reset, and no changes shall be made to the pump and valve status.

h. After the timer expires: The second pump shall start.

i. With the lead and second pumps running and a issue venturi flow rate greater than <1160> gpm and a return venturi flow rate of greater than <40> gpm and less than <700> gpm the lead and second pumps shall continue to run and the BPCV shall modulate as necessary to maintain system pressure.

j. With the lead and second pumps running and a issue venturi flow rate greater than <1160> gpm and a return venturi flow rate greater than <700> gpm a <15> second timer shall start. If issue venturi flow rate falls below <1160> gpm or the return venturi flow rate falls below <700> gpm before the timer expires, the timer shall reset and no changes shall be made to the pump and valve status.

k. After the timer expires: The second pump shall be stopped.

l. With the lead and second pump running and a issue venturi flow rate greater than <1160> gpm and a return venturi flow rate less than <40> gpm a <10> second timer shall start. If the issue venturi flow rate falls below <1160> gpm or the return venturi flow rate rises above <40> gpm before the timer expires, the timer shall reset, and no changes shall be made to the pump and valve status.

m. After the timer expires: The third pump shall start.

n. With the lead, second and third pumps running and a issue venturi flow rate greater than <1760> gpm and a return venturi flow rate of greater than <40> gpm and less than <700> gpm the lead, second and third pumps shall continue to run and the BPCV shall modulate as necessary to maintain system pressure.

o. With the lead, second and third pumps running and issue venturi flow rate greater than <1760> gpm and a return venturi flow rate greater than <700> gpm a <15> second timer shall start. If the issue venturi flow rate falls below <1760> gpm or the return venturi flow rate falls below <700> gpm before the timer expires, the timer shall reset and no changes shall be made to the pump and valve status.

p. After the timer expires: The third pump shall be stopped.

q. With the lead, second and third pumps running and a issue venturi flow rate greater than <1760> gpm and a return venturi flow rate less than <40> gpm a <10> second timer shall start. If the issue venturi flow rate falls below <1760> gpm or the return venturi flow rate rises above <40> gpm before the timer expires, the timer shall reset, and no changes shall be made to the pump and valve status.

r. After the timer expires: The fourth pump shall start.

s. With the lead, second, third and fourth pumps running and a issue venturi flow rate greater than 2360 gpm and a return venturi flow rate

of greater than <40> gpm and less than <700> gpm the lead, second, third and fourth pumps shall continue to run and the BPCV shall modulate as necessary to maintain system pressure.

t. With the lead, second, third and fourth pumps running and a issue venturi flow rate greater than 2368 gpm and a return venturi flow rate greater than <700> gpm a <15> second timer shall start. If the issue venturi flow rate falls below 2360 gpm or the return venturi flow rate falls below <700> gpm before the timer expires, the timer shall reset and no changes shall be made to the pump and valve status.

u. After the timer expires: The fourth pump shall be stopped.

v. When a fueling pump is called to start, a 15 second timer shall start. If the timer expires before the flow switch closes the pump shall be called off, the alarm annunciator's associated non-critical alarm sequence shall activate and the next pump in the sequence shall be called to start.

w. If a fueling pumps flow switch opens after the pump successfully started the pump shall be called off, the alarm annunciator's associated non-critical alarm sequence shall activate and the next pump in the sequence shall be called to start.

3.10 AUTOMATIC MODE - DEFUELING CONDITION

To start an aircraft defuel operation, an operator connects a hydrant hose truck to an aircraft and a fuel sense line and an air sense line to the hydrant control valve. The hydrant hose truck has an on-board defuel pump capable of delivering 300 gpm at 165 psig. When the operator starts the defuel operation one of the following occurs:

a. If the fueling pumps are running (D/FV closed) the fuel being removed from the aircraft will either go to the other aircraft(s) connected to the system or be returned to the pumphouse where the BPCV will modulate to control system pressure and the fuel will be returned to the operating tanks. The return venturi flow rate will control the number of pumps that are on as discussed in paragraph "AUTOMATIC MODE - FUELING CONDITION".

b. If the fueling pumps are off (D/FV enabled) the fuel being removed from the aircraft will be returned to the pumphouse and both the D/FV and the PCV will modulate to return the fuel to the operating tanks.

3.11 FLUSH MODE

This mode shall be used when the system need to be flushed of water or sediment. The operators shall first place the manual valve in the desired position to select the appropriate flow path. Placing the selector switch in "flush" the following shall occur:

a. The BPCV solenoid shall be de-energized to force it closed.

b. The D/FV solenoid 'A' shall be de-energized to allow the valve to open and the D/FV solenoid 'B' shall be energized to force it open.

c. Start the fueling pump(s) manually using the Hand-Off-Auto or Hand-Auto switch to obtain the desired flow rate. The automatic pump starts shall be disabled in this mode.

d. The PCV solenoid shall be energized when pump(s) are on and de-energized when the pumps are off.

e. When a fueling pump is started, a 15 second timer shall start. If the timer expires before the flow switch closes the alarm annunciator's associated non-critical alarm sequence shall activate.

f. If a fueling pumps flow switch opens after the pump successfully started the alarm annunciator's associated non-critical alarm sequence shall activate.

3.12 OFF MODE

a. Automatic starting of fueling pumps shall be disabled. All other functions (GDP, alarm annunciator, 2-pen recorder, operator interface, control valve solenoids, etc.) shall be active to allow manual control of the fueling pumps using the Hand-Off-Auto or Hand-Auto switch.

b. When the first pump has been started:

(1) The BPCV solenoid shall be energized to enable the valve to modulate the system pressure at it's set point.

(2) The PCV solenoid shall be energized to close the valve.

(3) The D/FV solenoid 'A' shall be de-energized so the valve is closed and solenoid 'B' shall be de-energized.

c. The second, third and fourth pumps maybe started or stopped manually as needed by the operator.

d. After the last pump has been stopped:

(1) The BPCV solenoid shall be de-energized.

(2) The PCV solenoid shall be de-energized.

(3) The D/FV solenoid 'A' shall be energized and D/FV solenoid 'B' shall be de-energized.

3.13 MANUAL OPERATION OF FUELING PUMPS

a. If the PLC system is still active see Paragraph "OFF MODE".

b. If the PLC system has no power or both CPUs have faulted (CPU lights on PCP off) the pumping system will be in a completely manual mode. The safety circuit will need power so that the ESO solenoids on the non-surge check valves will be open and fuel can flow. The solenoids on the other solenoid controlled valves will be de-energized so the valves will have to be manually opened or enabled for the system to run. Other valves may need to be opened or closed manually by the operators for the system to work properly.

-- End of Section --